203

HICKOK

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OPERATING INSTRUCTIONS

for

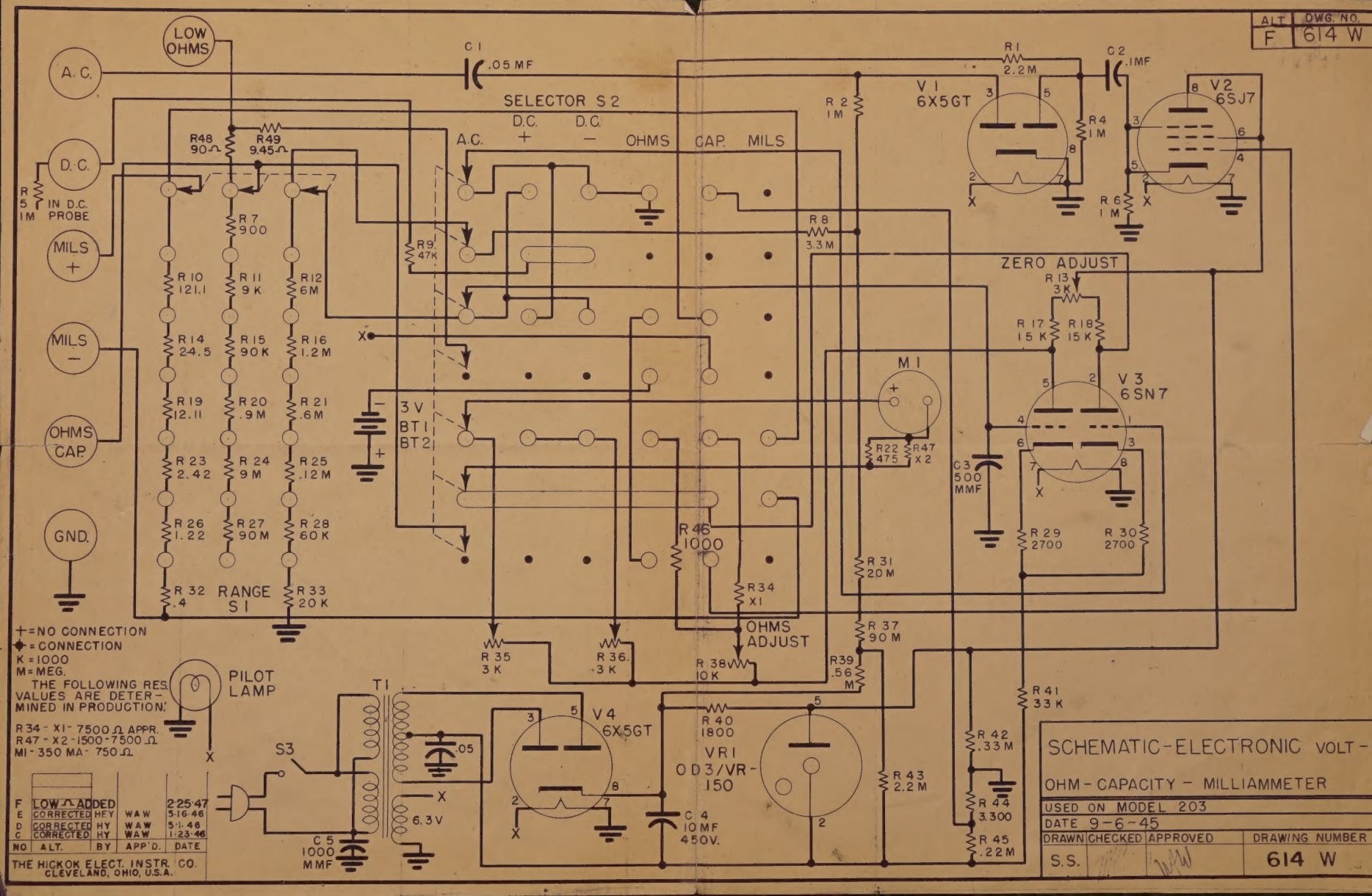
ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER

Model 203

PRICE 50 CENTS
PER COPY

Manufactured by

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10514 DUPONT AVENUE • CLEVELAND 8, OHIO



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D	CORRECTED	HY	WAW	5-1-46
C	CORRECTED	HY	WAW	1-23-46

THE HICKOK ELECT. INSTR. CO.
CLEVELAND, OHIO, U.S.A.

ALT	DWG. NO.
F	614 W

SCHEMATIC-ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER

USED ON MODEL 203

DATE 9-6-45

DRAWN	CHECKED	APPROVED	DRAWING NUMBER
S.S.			614 W

CAPACITY MEASUREMENTS OF THE 203 OR 209 WHEN USED ON OTHER THAN 60 CYCLE SUPPLY

A simple conversion factor may be used to convert capacity readings when using either the Model 203 or the Model 209 instrument for other than 60 cycle operation. This formula is as follows:

$$C_A = \frac{C_m 60}{f}$$

In this formula, C_A = Actual Capacity

C_m = Measured Capacity

f = Line Supply Frequency

In the case of 50 cycles, the above formula could be reduced to

$$C_A = 1.2\ C_m$$

CAPACITY MEASUREMENTS OF THE SO3 OR NOS WHEN USING ON OTHER THAN 60 CYCLE SUPPLY

A simple conversion factor may be used to convert capacity readings when using either the Model SO3 or the Model NOS instrument for other than 60 cycle operation. This formula is as follows:

$$C_A = \frac{C_M 60}{f}$$

In this formula, C_A = Actual Capacity

C_M = Measured Capacity

f = Line Supply Frequency

In the case of 50 cycles, the above formula could be reduced to

$$C_A = 1.2\, C_M$$

ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER

MODEL 203

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 Dupont Ave.
Cleveland 8, Ohio

IB-203-2-46-(1)

TABLE OF CONTENTS

Paragraph	Title	Page
	SECTION I DESCRIPTION	
1.1	Purpose	1
1.2	Description	1
	SECTION II THEORY	
2.1	General	2
2.2	Bridge Circuit	3
2.3	Voltmeter, AC	3
2.4	Voltmeter, DC	4
2.5	Ohmmeter	4
2.6	Capacity & Inductance Measurements	5
	SECTION III OPERATION	
3.1	General	5
3.2	AC Voltage Measurements	5
3.3	DC Voltage Measurements	6
3.4	Current Measurements	6
3.5	Resistance Measurements	6
3.6	Capacitance Measurements	6
3.7	Inductance Measurements	7
	SECTION IV APPLICATION	
4.1	General	8
4.2	DC Voltmeter	8
4.3	AC Voltmeter	9
4.4	Ohmmeter	9
4.5	Capacity Measurements	9
	SECTION V MAINTENANCE	
5.1	General	10
5.2	Vacuum Tubes	10
5.3	Dry Cells	11
	SECTION VI PARTS LIST	
	Parts List	12 - 13
	SECTION VII DRAWINGS	

LIST OF ILLUSTRATIONS

Figure	Title	Page
1.1	Electronic Volt-Ohm-Capacity-Milliammeter, Model 203	ii
1.2	Test Leads	1
2.1	Milliammeter Circuit	2
2.2	Basic Bridge Circuit	3
2.3	AC Voltmeter Circuit	3
2.4	DC Voltmeter Circuit	4
2.5	Ohmmeter Circuit	4
2.6	Capacity and Inductance Measurements	4
3.1	Impedance Chart	8
5.1	Tube Location, Model 203	10
5.2	Chassis View, Model 203	11
7.1	Schematic, Model 203	14

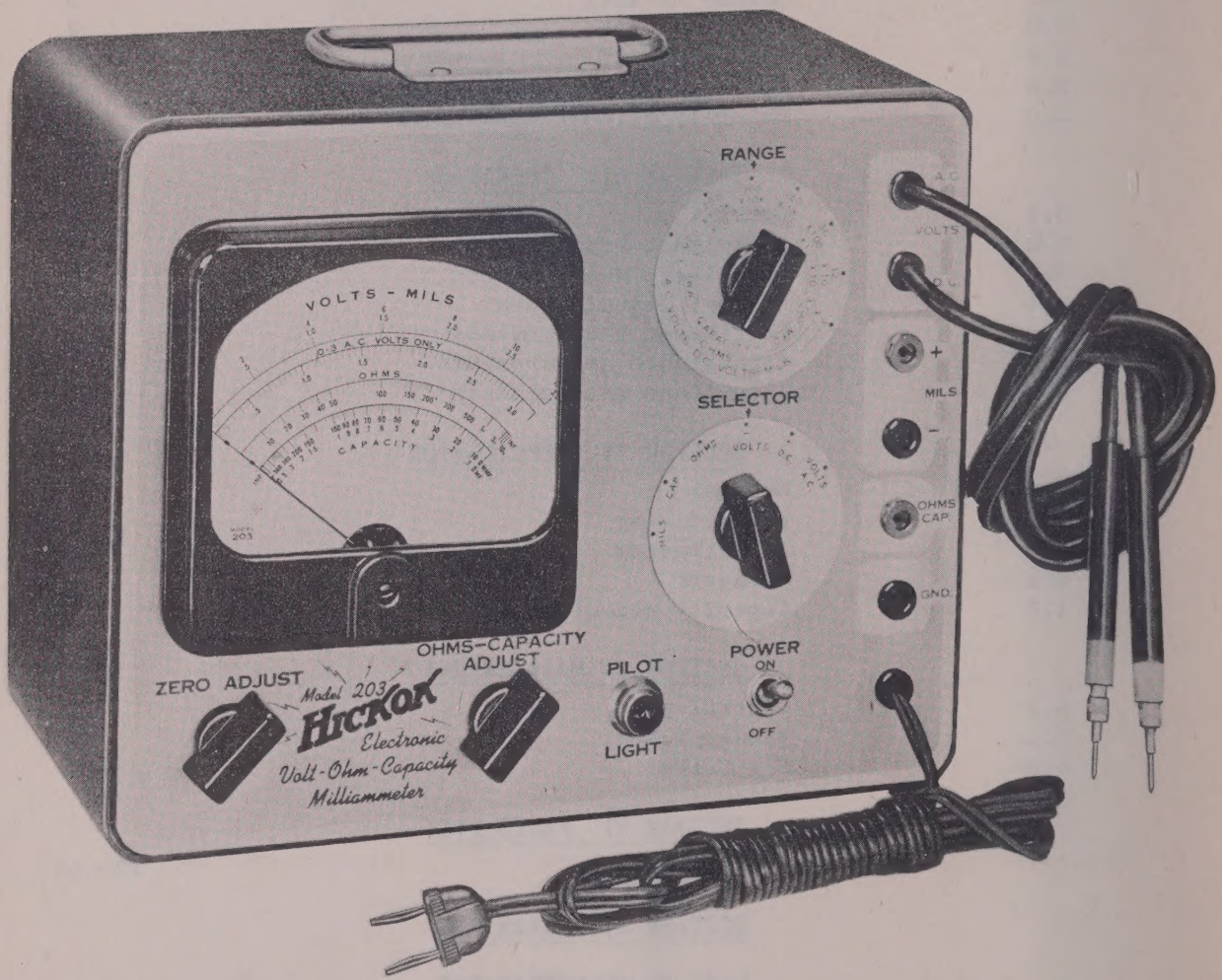


FIGURE 1.1 - ELECTRONIC VOLT-OHM-CAPACITY-MILLIAMMETER, MODEL 203

TECHNICAL DATA SHEET

EQUIPMENT SUPPLIED
(One Complete Unit)

Quan.	Name	Type	Stock No.	Dimensions	Weight
1	Electronic Volt-Ohm-Capacity Milliammeter	203	902-036	11¼" X 9" X 5¼"	12.5 lbs.
1	Instruction Book		2490-60		
1	Test Lead - Red		12450-93	42"	
1	Test Lead - Black		12450-99	42"	

TECHNICAL CHARACTERISTICS

1. Power Supply Required: 105 - 125 V, 50 - 70 cycles, a-c

2. Power Consumption: 20 watts at 115 V

3. Scales:

   a. VOLTS MILS: 0 - 3, 0 - 12
   b. 0-3 VOLTS A-C ONLY: 0 - 3
   c. OHMS: 0 - 10,000 - Inf.
   d. CAPACITY: MMF - 0 - 1000 - Inf.
      MF - 0 - 10 - Inf.

4. Ranges:

   a. VOLTS, A-C: 0 - 3, 12, 30, 120, 300, 1200
   b. VOLTS, D-C: 0 - 3, 12, 30, 120, 300, 1200
   c. MILS (d-c): 0 - 3, 12, 30, 120, 300, 1200
   d. CAP: 0 - 10,000 mmf, in 2 ranges
      0 - 1000 mf, in 5 ranges
      50 mh - 100 henries (use conversion chart)
   3. OHMS: 1 ohm to 10,000 megohms, in 7 ranges

5. Frequency: A-C up to approximately 5 megacycles may be measured.

6. Meter:

   a. Type: S44
   b. Sensitivity: 350 Microamperes

7. Tube Complement:

	Tube	Stock No.	Function
V1	6X5GT	20875-22	A-c input rectifier
V2	6SJ7	20875-17	Cathode follower
V3	6SN7GT	20875-19	Vacuum tube voltmeter
V4	6X5GT	20875-22	A-c power rectifier
VR1	OD3/VR150	20875-39	Voltage regulation

GUARANTEE

HICKOK TESTING EQUIPMENT IS GUARANTEED AGAINST INACCURACY OR DEFECT IN MATERIAL OR WORKMANSHIP FOR A PERIOD OF 90 DAYS AFTER DATE OF SHIPMENT FROM OUR FACTORY. ADJUSTMENT UNDER TERMS OF THIS GUARANTEE WILL BE MADE BY THE FACTORY OR OUR REPAIR STATION WITHOUT CHARGE. THIS GUARANTEE DOES NOT COVER TRANSPORTATION CHARGES TO OR FROM OUR FACTORY OR REPAIR STATIONS.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Address all service inquiries to The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

SECTION I - DESCRIPTION

1.1 PURPOSE

The Hickok Electronic Volt-Ohm-Capacity Milliameter, Model 203, shown in Figure 1.1, is a compact practical universal test instrument which may be used in making measurements in the study of radio and electrical circuits. It is a versatile instrument as the measurement of wide ranges of d-c currents, a-c and d-c voltages, resistances, capacitances and inductances may all be made by the one unit. Built under Hickok high standards of workmanship, it is an accurate and durable test instrument.

1.2 DESCRIPTION

a. Physical

1. The instrument is enclosed in a metal case with a handle at the top and with feet on two sides so that the instrument may be used in either a horizontal or vertical position. The chassis is mounted on the front panel and is accessible by removing the eight screws holding the panel to the case and then removing the panel. The meter is accurately calibrated with the scales clearly marked. A mechanical adjustment of the zero setting is provided on the front of the meter. The leads used in making voltage measurements are permanently attached to the instrument as is the a-c power cable. Two additional leads are furnished for all other measurements. All switches, pin jacks and ranges are clearly marked on the front panel.

2. Two leads, A-C and D-C, are permanently attached to the panel. These are shielded cables, 42 inches long with prods on the free ends. The lead with the yellow tip is for d-c measurements and has an isolating resistance incorporated in the lead to prevent loading when measurements are made. The lead with the red tip is for a-c measurements. Both leads are used in conjunction with the ground lead that is furnished with the unit.

b. Components

Two detachable leads, shown in Figure 1.2, are furnished with the instrument. One of these leads, red, is terminated at one end with a prod at the other end with a tip plug. The other lead, black, is terminated at one end with an alligator clip and at the other end with a tip plug. The black lead is commonly used as a ground lead.

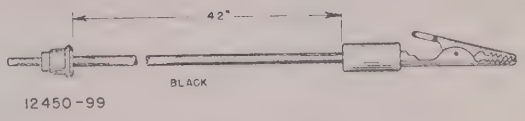


FIGURE 1.2 - TEST LEADS

c. Functional

The instrument is designed primarily to perform the following electrical functions:

1. To measure a wide range of d-c currents, a-c and d-c voltages, resistances, capacitances and inductances.

2. To have a very light loading effect when making measurements because of the high impedance of the instrument.

3. To have a meter circuit so designed that there is no possibility of damage to the meter except in the measurement of currents.

d. Electrical

1. A 105 - 125 volt, 50 - 70 cycle a-c external power source is needed for the operation of the power supply system which has been incorporated in the unit to supply all d-c plate voltages and a-c heater voltages. The power supply circuit is of the conventional type consisting of a transformer, rectifier, filter and voltage regulator. D-C voltage

needed for ohmmeter measurements is supplied by two dry cells, in series, also incorporated in the instrument.

2. Three separate voltage divider networks are used in the input circuit; one for current measurements, one for resistance and capacitance measurements and one for a-c and d-c voltage measurements. The SELECTOR switch determines which network is to be used and the RANGE selector switch determines the position within the network. A switching arrangement has been incorporated so that voltages either positive or negative with respect to ground may be measured by merely operating the switch to the correct d-c position rather than reversing the position of the leads themselves.

3. The method of obtaining the voltage that is fed into the grid depends upon the type of measurement to be made. In measuring d-c currents and voltages, the voltage is obtained by simply placing the input across the proper input voltage divider network and tapping off that portion necessary to keep the meter on scale for the range to be measured. In a-c voltage measurements, the a-c is rectified by one section of a rectifier tube before being placed across the divider network. In resistance and capacitance measurement the unknown is placed in series with the portion of the divider network which determines the current through the unknown and the subsequent voltage across it which is fed to the grid of the voltmeter tube. In capacitance measurements, the a-c voltage developed is rectified by the remaining section of the previously mentioned rectifier after first going through the impedance matching circuit of a cathode follower.

SECTION II - THEORY

2.1 GENERAL

A thorough understanding of the theory behind the operation of any instrument will enable the user to obtain greater utility and satisfaction from the instrument. For this reason the following brief explanation of the circuit of the Hickok Electronic Volt-Ohm-Capacity Milliammeter Model 203 is given. As the principles of operation rather than detailed explanation of the operation is intended, the full schematic, shown in Figure 7.1, is greatly simplified. The power supply incorporated in the unit is of the usual type employing a transformer, full-wave rectifier and a voltage regulator tube, therefore, no explanation is given of it. The milliameter circuit, as shown in Figure 2.1, also needs no detailed explanation as it is simply a meter shunted by a resistance network whose value is determined by the range of the current to be measured.

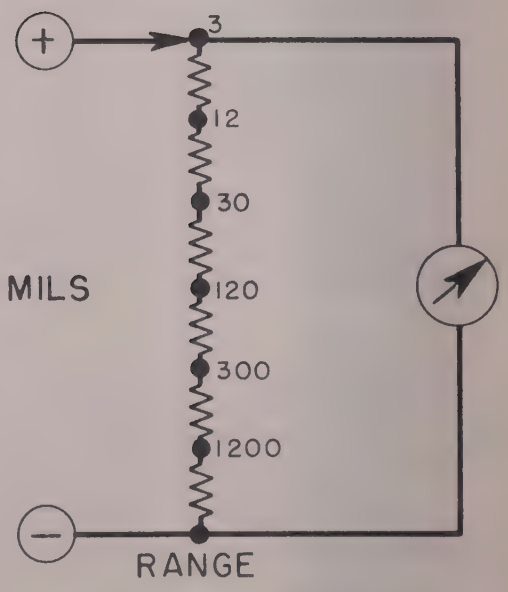
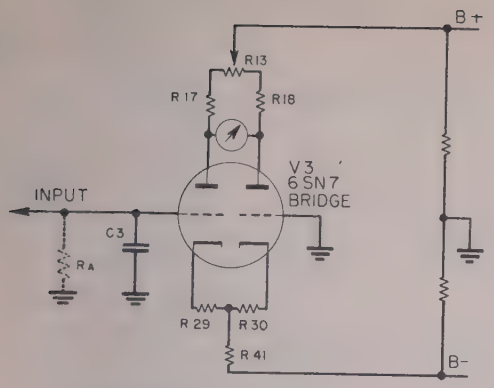


FIGURE 2.1 - MILLIAMMETER CIRCUIT



R_A = RESISTANCE OF THE CIRCUIT

FIGURE 2.2 - BASIC BRIDGE CIRCUIT

2.2 BRIDGE CIRCUIT

a. The bridge circuit is common to all measuring circuits except the milliammeter section. Specific application of the bridge is given in the explanation of the type of measurement to be performed, i.e., resistance, capacitance or voltage.

b. The basic circuit of the bridge, which is similar to the common Wheatstone bridge in operation, is given in Figure 2.2. Voltage is applied across the bridge; B+ at R13 and B-, through feeder resistor R41, at the junction of R29 and R30. R13 acts as a zero adjustment and is adjusted so that with no voltage input to either grid of the tube, the meter reads zero, indicating balance between the two triodes of the twin triode used as the bridge tube. When making all measurements except capacity measurements the grid of one triode remains at ground potential and the grid of the other triode changes to a potential determined basically by the unknown being measured. Changing the potential of only one of the grids will unbalance the bridge and cause a deflection of the meter in direct proportion to the change in grid potential as the plate current changes with grid potential. The meter has a calibrated scale which interprets this deflection in terms of volts, ohms, or units of capacity so that, in conjunction with the RANGE selector, the unknown can be evaluated directly from the scale reading. This is basically the action of the bridge and meter. The type of measurement to be made will determine both the input grid to be used and the method of obtaining the input voltage.

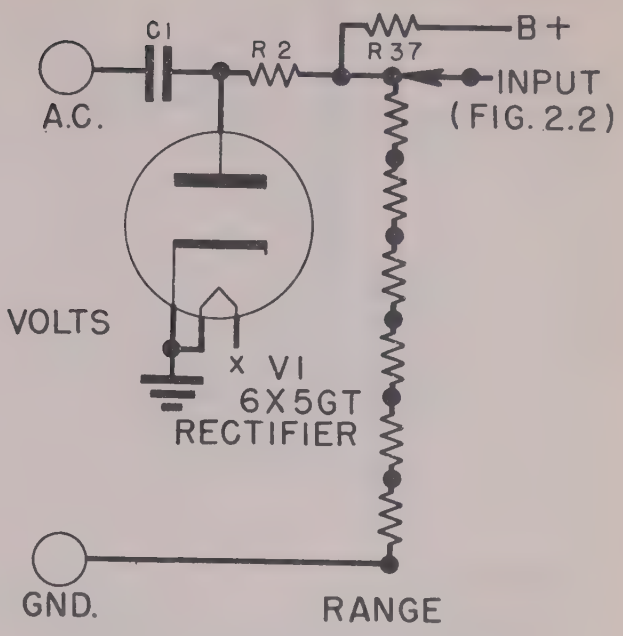


FIGURE 2.3 - AC VOLTMETER CIRCUIT

2.3 VOLTMETER, AC

a. The a-c input voltage, applied to the AC and GND connections of the instrument, is rectified by the action of the input condenser C1 and one section of the rectifier VI, as shown in Figure 2.3. This resultant d-c voltage is applied across the input voltage divider network and part of this voltage, as determined by the position of the RANGE control, is fed to the input grid of one of the triodes of the bridge tube causing the bridge circuit to function.

b. A negative contact potential is developed across the rectifier tube before any input voltage is applied due to the normal emission of electrons by the cathode. This negative potential is also across the input voltage divider network and will cause the meter to deflect. To compensate for this undesirable deflection, a positive voltage, equal to the contact potential, is fed to the voltage divider network through a 90 megohm resistor R37.

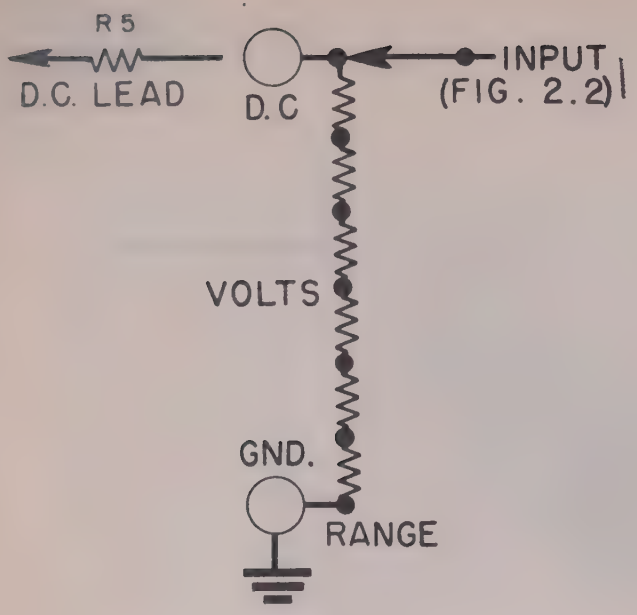


FIGURE 2.4 - DC VOLTMETER CIRCUIT

2.4 VOLTMETER, DC

The d-c input voltage, applied to the D-C and GND connections of the instrument, is applied directly to the voltage divider network, as shown in Figure 2.4. A part of this voltage, as determined by the position of the RANGE control, is fed to the input grid of one of the triodes of the bridge tube, causing the bridge circuit to function. Deflection of the meter pointer in the wrong direction indicates that the polarity of the voltage being measured is reversed with respect to the polarity of the meter and bridge circuit. A switching arrangement has been incorporated in the instrument, however, which switches the input grids of the bridge tube to permit measurements of either polarity.

2.5 OHMMETER

When an unknown resistance is connected across OHMS-CAP and GND terminals it is placed, as shown in Figure 2.5, in series with a portion of the input voltage divider network, as determined by the RANGE control. The d-c voltage, of the dry cells incorporated in the instrument, placed across the combined resistances will cause a current to flow.

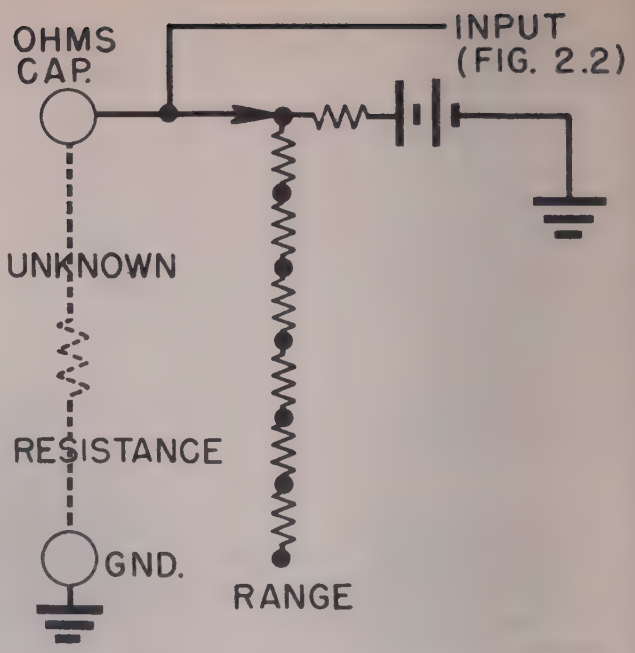


FIGURE 2.5 - OHMMETER CIRCUIT

The voltage applied to the input grid of the bridge tube is the product of the unknown resistances and this current and thus the meter deflection can be calibrated in the terms of resistance.

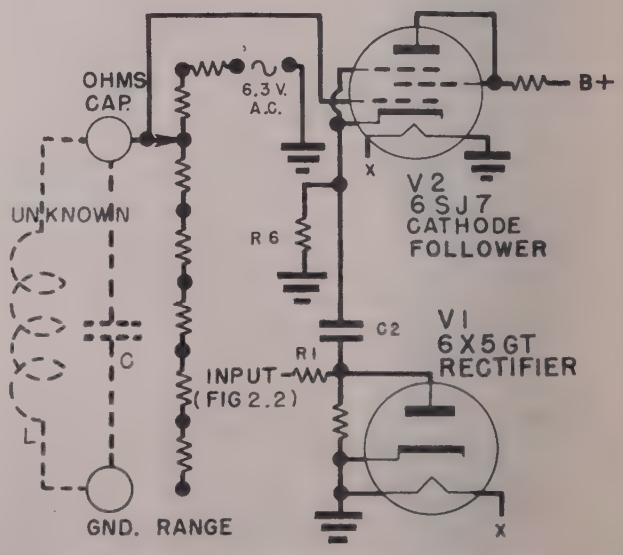


FIGURE 2.6 - CAPACITY AND INDUCTANCE MEASUREMENTS

2.6 CAPACITY AND INDUCTANCE MEASUREMENT

a. Capacity

The theory of the capacity measurement is similar to that of the ohmmeter, with the impedance of the unknown capacitor replacing the unknown resistance, as shown in Figure 2.6. However, as an a-c voltage is needed to measure the capacitance, and as only d-c can be applied to the input grid of the bridge tube, some means must be used to rectify the a-c. The a-c voltage tapped off the voltage divider network is fed to the grid of a cathode follower which is used in the circuit as an impedance matching device. The cathode output is fed to the rectifier circuit which consists of one half of V1, a condenser C2 and a resistance R6. The output of the rectifier is fed to the input grid of the bridge tube.

b. Inductance

The theory of the inductance measurements is similar to that of a capacitance measurement with the impedance of the inductance coil replacing the impedance of the capacitor. As the capacity scale is used in making measurements a chart is given in Figure 3.1 Section III, Operation, which relates capacity readings to impedances. This impedance, in its affect in the circuit, may be due to either an inductance or a capacitor. A second scale on the chart evaluates the coil directly in henries and may be used if the ohmic resistance of the coil is low.

SECTION III - OPERATION

CAUTION

THE HIGH VOLTAGES WHICH CAN BE MEASURED WITH THIS EQUIPMENT MAY BE DANGEROUS TO LIFE. EXTREME CARE SHOULD BE TAKEN TO AVOID BODILY CONTACT WITH EXPOSED HIGH VOLTAGES.

3.1 GENERAL

a. To avoid error in resistance, capacitance and inductance measurements, be sure that the unknown to be measured is isolated from other circuits. In capacity and inductance measurements, it is advisable to remove the unknown from the circuit entirely. In resistance measurements, it is sufficient to free only one terminal of the resistor.

b. Be sure that the instrument is being operated from the correct external power supply. It is necessary to allow two or three minutes after the power is turned on for the instrument to become stable. To avoid delay due to this warm-up period, it is advisable to keep the instrument turned on if it is to be used intermittently over a period of time.

3.2 AC VOLTAGE MEASUREMENTS

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to VOLTS AC.

c. Turn the RANGE selector to the range which will cover the voltages to be measured. If an approximate range is unknown, choose the highest range.

d. Check the meter for zero setting at the range in which the measurement is to be made. Adjust to zero with the ZERO ADJUST control

e. Connect the unknown, using the black ground lead furnished and the permanently attached cable with the red prod.

f. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE control.

3.3 DC VOLTAGE MEASUREMENTS

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to VOLTS +DC.

c. Turn the RANGE selector to the range which will cover the voltages to be measured. If an approximate range is unknown, choose the highest range.

d. Check the meter for zero setting at the range at which the measurement is to be made. Adjust to zero with the ZERO ADJUST control.

e. Connect the unknown, using the black ground lead furnished and the permanently attached cable with the yellow prod.

f. If the meter reads in the wrong direction, operate the SELECTOR switch to VOLTS - DC.

g. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE control.

3.4 CURRENT MEASUREMENTS

a. To avoid possible injury to the meter, always make measurements using the highest range first.

b. To avoid error due to an inaccurate initial setting of the meter, check the zero reading of the meter before making any measurements. Adjust the zero setting mechanically by means of the screwdriver adjustment in the front of the meter if necessary.

c. Turn the SELECTOR switch to MILS.

d. Turn the RANGE selector to the range which will cover the currents to be measured. If an approximate range is unknown, choose the highest range.

e. Connect the unknown, using the black ground lead for -MILS and the red lead for +MILS.

f. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE control.

3.5 RESISTANCE MEASUREMENTS

a. Operate the POWER to ON.

b. Turn the SELECTOR switch to OHMS.

c. Turn the RANGE switch to the range which will cover the resistances to be measured.

d. Connect the red and black leads furnished, to OHMS CAP and GND, respectively, and check the meter for zero setting by shorting the leads together. Adjust the zero with the ZERO ADJUST control. Open the leads and check for full scale deflection. Adjust to full scale with the OHMS-CAPACITY ADJUST control.

e. Connect the unknown resistance making sure that it is isolated from any other circuit components which might introduce error.

f. Read the numerical value from the scale directly and apply the multiplying factor for the position of the RANGE control.

3.6 CAPACITANCE MEASUREMENTS

NOTE

Since the instrument has an appreciable internal capacity of approximately 20 - 30 μμf, the meter, when the range switch is turned to the X1 MMFD range will read this capacity. When making adjustment of the instrument to zero with the OHMS CAPACITY ADJUST control, always turn the RANGE selector switch to some position other than X10 or X1 MMFD since in other positions the small internal capacity will have no effect. In cases where it is necessary to make measurements in the X1 or X10 range, the true capacity will always be the difference between the reading obtained with the unknown capacity connected to the input and the initial reading obtained with no external capacity connected.

a. Operate the POWER switch to ON.

b. Turn the SELECTOR switch to CAP.

c. Turn the RANGE selector to the range which will cover the capacity to be measured.

d. Connect the black and red leads furnished to OHMS CAP and GND and check the zero setting by shorting the leads together. In making this check, turn the RANGE selector to any position other than X1 MMFD or X10 MMFD as the internal capacity of the instrument will have an effect on the reading in these two positions. Adjust to zero with the ZERO ADJUST control. Open the leads and check for full scale deflection. Adjust to full scale with the OHMS-CAPACITY ADJUST control.

e. Connect to the unknown, using the black and red leads furnished. The capacitor should be removed from its associated circuits in making this measurement.

f. Multiply the numerical value indicated on the scale by the multiplying factor indicated by the RANGE control. In cases where it is necessary to use the X1 and X10 MMFD ranges, the true value of the unknown will be the difference between the meter reading with and without the capacitor connected.

3.7 INDUCTANCE MEASUREMENTS

a. Procedure

1. Operated the POWER switch ON.

2. Turn the SELECTOR switch to CAP.

3. Connect the black and red leads furnished to OHMS CAP and GND and check the zero setting by shorting the leads together. The RANGE selector switch should be in any position other than X1 MMFD. Adjust to zero with ZERO ADJUST control. Open the leads and check for full scale deflection. Adjust to full scale with the OHMS-CAPACITY ADJUST control.

4. Turn the RANGE selector to the range which will give an adequate reading. If the range is other than X1 MFD, values indicated in the graph given in Figure 3.1 must be converted as it is drawn on the basis of microfarads. Any change in units must be made inversely on the impedance scale, i.e., if the reading is X.1 MFD, multiply the impedance, or inductance, scale by 10.

5. Connect to the unknown inductance using the black and red leads. The inductance should be removed from any associated circuits in making this measurement.

6. Read the numerical capacity value directly from the capacity scale. Find the associated impedance on the graph given in Figure 3.1, making sure to compensate for any change in units from microfarads, as explained in 4, above. This value is Z_L in the formula for determining inductances which is given in 8, below.

7. Determine the resistance of the inductance by means of an ohmmeter. This value is R_L in the same formula.

8. All necessary values are now available for determining the inductance, L, of the coil in accordance with the following formula:

$$Z_L^2 = (2\pi fL)^2 + R_L^2$$ where π is 3.1416 and f is 60 cycles. This formula, however, can be further simplified by rearranging and extracting the square root;

$$L^2 = \frac{Z_L^2 - R_L^2}{(2\pi f)^2} \quad \text{or} \quad L = \frac{\sqrt{Z_L^2 - R_L^2}}{377}$$

where $2\pi f = 377$

Substitute the values obtained in 6 and 7, above. If R_L is negligible, L may be read directly from the inductance scale of the graph.

b. EXAMPLE: The following example is given to illustrate the above: It is desired to find the inductance of a coil whose resistance, when measured by an ohmmeter, is 100 ohms.

1. Make measurements of the coil as given in a, above. Assume the capacity

reading is 8.8 MFD, Z_L is found to be 300 ohms by use of the graph in Figure 3.1.

2. Substituting the known values in the formula:

$$L = \frac{\sqrt{Z_L^2 - R_L^2}}{377}$$

Obtain $L = \frac{\sqrt{90{,}000 - 10{,}000}}{377}$ or

$$L = \frac{282}{377} = .748 \text{ henries}$$

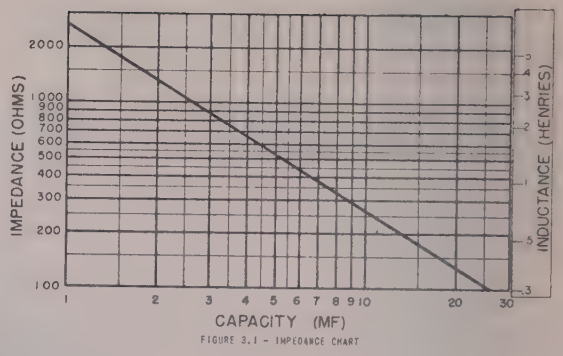


FIGURE 3.1 - IMPEDANCE CHART

SECTION IV- APPLICATION

4.1 GENERAL

The following applications are very general in nature as it is always advisable to consult the instructions pertinent to the instrument under test to obtain the actual procedures in making a test. The Hickok Electronic Volt-Ohm-Capacity - Milliammeter, Model 203, may, of course, be used in making all measurements common to an instrument of its type. These applications given here will give more specialized use of which the user may not be aware.

4.2 DC VOLTMETER

a. The input impedance in the vacuum tube voltmeter is constant at approximately 10 megohms for all ranges. As the result of this high input impedance, it can, in general, be used to measure d-c voltages in any electrical circuit without appreciably loading down the d-c circuit and, consequently, the voltage as indicated will be essentially the voltage which would be found under normal operating conditions. In the conventional low impedance type of voltmeter the loading caused by the meter is often sufficiently great to cause extreme error when measurements are made in high impedance circuits.

b. RF-IF Circuits

As a result of the incorporation of an isolating resistor of one megohm in the d-c probe, this voltmeter can also be used to measure voltages in oscillating or r-f circuits without loading these circuits from a capacitive or resistive standpoint. This feature makes it possible to measure a-v-c voltages at such places as the control grids of r-f and i-f stages without disturbing the normal operation of those circuits.

c. Oscillation Check

Determination of the condition of oscillation, or non-oscillation, of the oscillator sections in receivers is another application of the voltmeter. An immediate check is obtained on the oscillator section by connecting the voltmeter so as to measure the voltage at the grid of the oscillator tube and tuning from one end of the band to the other. Note the grid voltage throughout the entire range. Normally a negative voltage of from 5 to 30 volts will be found at the grid of the oscillator tube when the oscillator section is operating properly. Dead spots on one or more of the tuning ranges may be located by this test.

d. Discriminator Circuit Alignment

Service instructions for the alignment of frequency modulated receivers often call for the insertion of a zero center microammeter in the discriminator circuit. Misalignment is indicated by any reading, either positive or negative, on the meter and alignment is indicated by a zero reading. The d-c voltmeter section of the Hickok Model 203 may be much more conveniently used to make such alignments. Merely connect it across the discriminator load resistance and advance the zero adjust control to bring the normal position of the pointer of the meter to some arbitrary position on the scale where swings either positive or negative may be noted. Make the necessary alignment which will bring the meter back to the position at which it had been set prior to the connection to the discriminator load resistance. Thus a satisfactory alignment can be made without the necessity of breaking the circuit to insert the microammeter.

4.3 AC VOLTMETER

a. The a-c voltmeter has a constant a-c input impedance of approximately 11 megohms which is shunted by the capacity of the lead and associated capacitors which amounts to approximately 100 uuf. Throughout the audio frequency range a shunt of this capacity will not seriously load the circuit under test and consequently a-c voltage measurements may be made without appreciably disturbing normal operation of the circuit. The a-c voltmeter may be used up to the frequency of 10 to 15 megacycles with no appreciable error in the voltage determination although at these frequencies the loading imposed by the capacity input will probably seriously detune the tuned radio frequency circuits.

b. The a-c input circuit includes a blocking condenser between the test load and the internal circuit so that any d-c components present in the circuit under test are ineffective and only the a-c components are measured.

c. When the a-c voltmeter is used to measure voltages of supply line frequency, for example the common 60 cycle supply, small discrepancies in the readings may occur if the polarity of the test leads is reversed - that is, if the grounded test lead changes in position with respect to the a-c voltage being measured. The actual voltage in such cases should be taken as the average of the two readings obtained.

4.4 OHMMETER

a. The ohmmeter section of the Model 203 uses only 3 volts, d-c, for all resistance measurements. Many resistors, especially of the composition type, have what is known as a voltage coefficient, that is, the actual value of the resistance varies with the voltage placed across the resistors. This is especially true at resistance values above one megohm. As an example of this, a resistor measured with 3 volts, as in the Model 203, to be 5 megohms might differ from 5 megohms if it were measured with several hundred volts. This difference would depend on the voltage coefficient of the resistor.

b. On the lower ranges the internal shunt resistance between the test leads used in resistance measurements is relatively low. It is advisable, therefore to never connect the test leads across a voltage which could possibly damage or destroy these resistors. To avoid this be sure that the resistor being measured is not connected to an active circuit when measurements are being made.

4.5 CAPACITY MEASUREMENTS

In conventional capacitance measuring devices it is necessary to use very high voltages for measuring capacitors of low capacity with a resultant hazard to the operator. This hazard has been completely eliminated in the Model 203 and capacity test leads may be handled without fear of electrical shock as the electronic circuit utilized permits capacity measurements throughout the wide range of from approximately 1 μμf to 1000 μf with the use of only 6 volts, a-c.

5.1 GENERAL

As the Model 203 has been built under the high standards of workmanship of a Hickok instrument, no maintenance other than routine replacement of tubes or batteries should be necessary. It is suggested that, should the instrument need maintenance other than routine replacements, the factory be contacted with regard to the nature of the trouble, and, if necessary, the instrument be shipped to the factory or an authorized repair station. A schematic, shown in Figure 7.1, and a chassis view, shown in Figure 5.2, are given to aid in maintenance work.

5.2 VACUUM TUBES

All vacuum tubes are operated at, or below, their normal rating to insure long life and uniform service. The location of the tubes is shown in Figure 5.1. To check the tubes, remove the chassis from the case by removing the eight cap nuts around the edge of the panel and lifting the panel from the case.

5.3 DRY CELLS

Two dry cells are operated in series as a source of d-c in making ohmmeter measurements. If it is impossible to bring the meter to full scale deflection on any scale it is probable that one or both of the dry cells are dead. To replace these, remove the chassis from the case as given in Paragraph 5.2, above, and remove the dry cells. It will be necessary to remove the clamp holding the cells in place first before removing the cells from their clip holders.

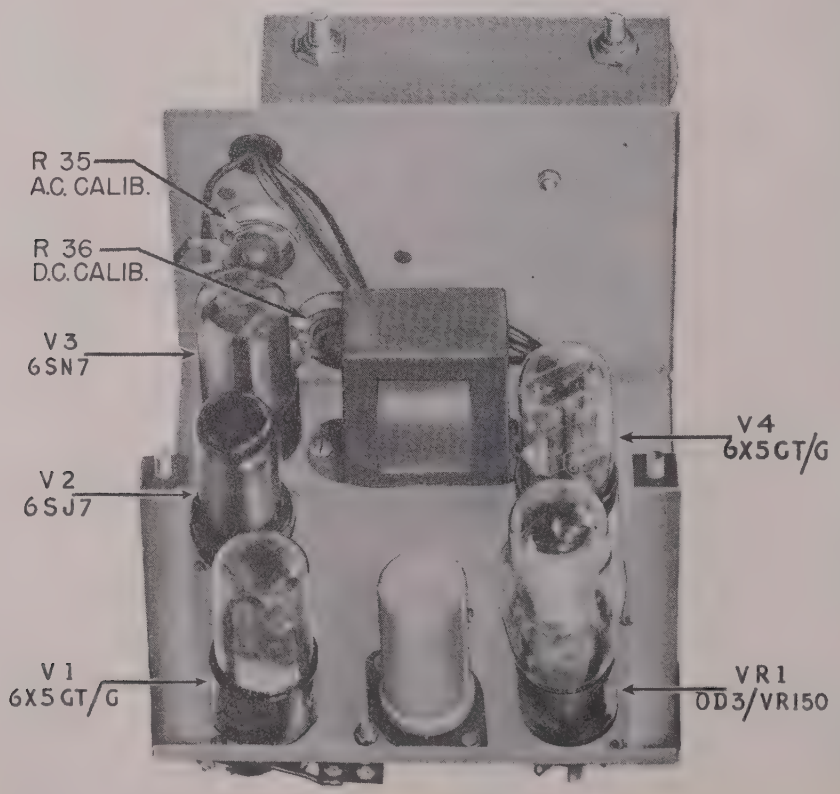


FIGURE 5.1 - TUBE LOCATION, MODEL 203

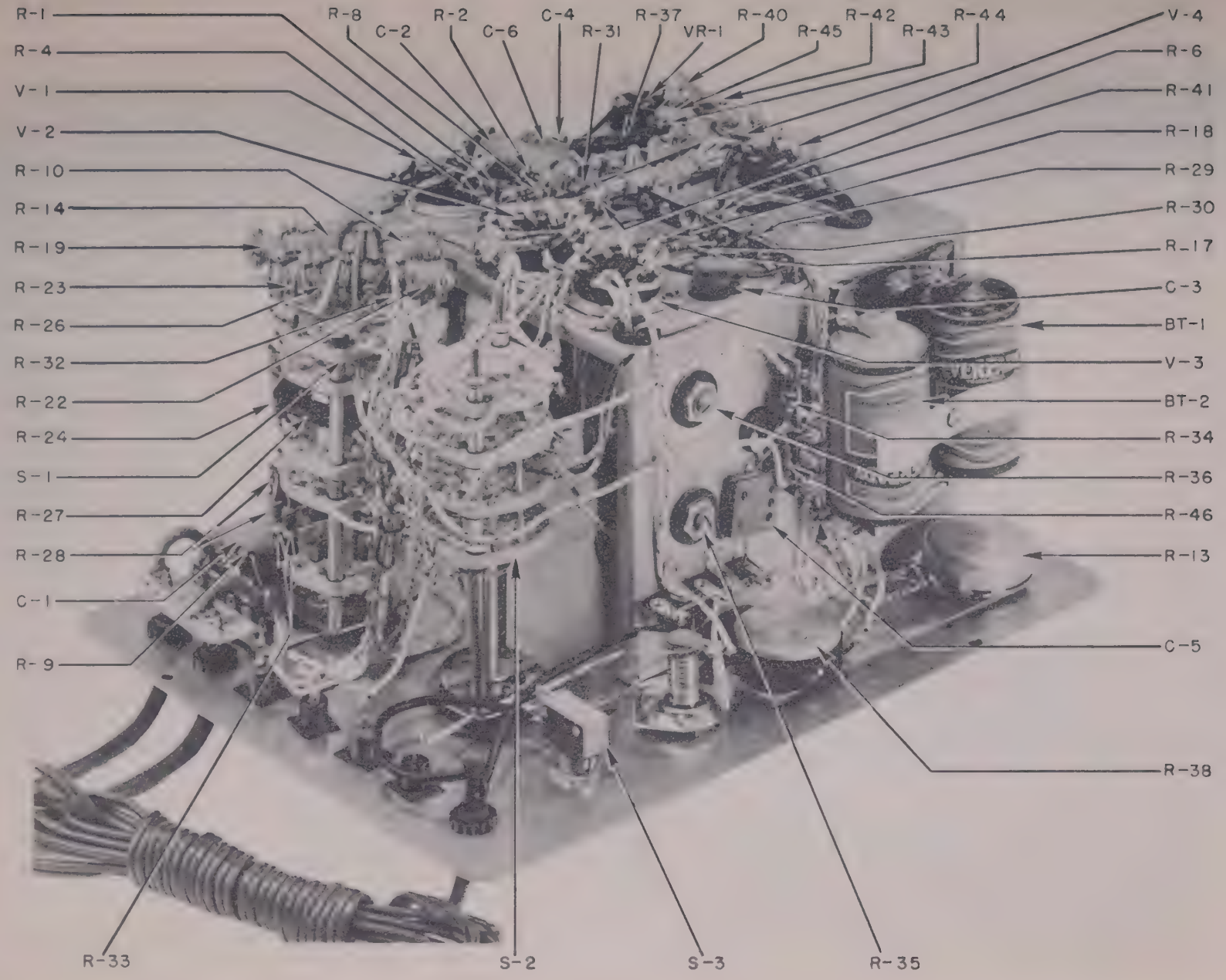


FIGURE 5.2 - CHASSIS VIEW MODEL 203

SECTION VI - PARTS LIST

PARTS LIST FOR MODEL 203

NOTE: There is a minimum charge of $1.50 for the shipment of any one order

Ref. Symbol	Hickok Stock Number	NAME AND DESCRIPTION	FUNCTION	Unit Cost
BT1	2210-2	BATTERY: 1½ V, unit cell, size D		$ .30
BT2		BATTERY: Same as BT1		.30
C1	3105-56	CAPACITOR: .05 mf, 1000 V, tubular, paper, wax, impregnated.		.35
C2	3105-24	CAPACITOR: .1 mf, 400 V, tubular, paper, wax, impregnated.		.20
C3	3095-26	CAPACITOR: .0005 mf, 500 V, 10%, mica.		.15
C4	3085-25	CAPACITOR: 10 mf, 450 V, electrolytic, tubular.		.70
C5	3095-19	CAPACITOR: 1000 mmf, 10%, mica.		.20
C6	3105-9	CAPACITOR: .05 mf, 400 V		.20
M1	440-178	METER: type S44, Sensitivity 350 microamperes.		13.37
R13	16925-11	POTENTIOMETER: 3,000 ohms, linear, composition.		1.20
R35	16925-12	POTENTIOMETER: 3,000 ohms, linear, wire wound.		.70
R36		POTENTIOMETER: Same as R35.		.70
R38	16925-27	POTENTIOMETER: 10,000 ohms, linear, composition.		.75
R1	18525-197	RESISTOR: 2.2 meg, 10%, ½ W, composition.		.10
R43		RESISTOR: Same as R1.		.10
R2	18525-90	RESISTOR: 1 meg, 10%, ½ W, composition.		.10
R4		RESISTOR: Same as R2.		.10
R6		RESISTOR: Same as R2.		.10
R3	18525-9	RESISTOR: 100 ohms, 2%, ½ W, composition, paired.		.35
R7	18525-20	RESISTOR: 900 ohms, 2%, ½ W, composition, paired.		.35
R8	18475-83	RESISTOR: 3.3 meg, 10%, ½ W, composition.		.10
R9	18475-79	RESISTOR: 47,000 ohms, 10%, ½ W, composition.		.10
R10	18670-417	RESISTOR: 121.1 ohms, 1 W, spool, medium.		.70
R11	18525-37	RESISTOR: 9,000 ohms, 2%, ½ W, composition, paired.		.35
R12	18525-207	RESISTOR: 6 mg, 2%, ½ W, composition, paired.		.35
R14	18670-408	RESISTOR: 24.25 ohms, 1 W, spool, medium		.70
R15	18525-61	RESISTOR: 90,000 ohms, 2%, ½ W, composition, paired.		.35
R16	18525-142	RESISTOR: 1.2 meg, 2%, ½ W, composition, paired.		.35
R17	18525-268	RESISTOR: 15,000 ohms, 5%, ½ W, composition.		.10
R18		RESISTOR: Same as R17.		.10
R19	18670-106	RESISTOR: 12.11 ohms, 1 W, spool, small.		.60
R20	18525-263	RESISTOR: 900,000 ohms, 2%, ½ W, composition, paired.		.35
R21	18525-141	RESISTOR: 600,000 ohms, 2%, ½ W, composition, paired.		.35
R22	18670-123	RESISTOR: 475 ohms, 1 W, spool, small.		.75
R23	18670-102	RESISTOR: 2.42 ohms, 1 W, spool, small.		.70
R24	18525-264	RESISTOR: 9 meg, 2%, ½ W, composition, paired.		.35
R25	18525-147	RESISTOR: 120,000 ohms, 2%, ½ W, composition, paired.		.35
R26	18670-102	RESISTOR: 1.22 ohms, 1 W, spool, small.		.70
R27	18550-71	RESISTOR: 90 meg, 10%, 1 W, composition.		.35
R37		RESISTOR: Same as R27.		.35
R28	18525-57	RESISTOR: 60,000 ohms, 2%, ½ W, composition.		.35

SECTION VI - PARTS LIST FOR MODEL 203

NOTE: There is a minimum charge of $1.50 for the shipment of any one order.

Ref. Symbol	Hickok Stock Number	NAME AND DESCRIPTION	FUNCTION	Unit Cost
R29	18252-265	RESISTOR: 2400 ohms, 5%, ½ W, composition.		.10
R30		RESISTOR: Same as R29.		.10
R31	18450-59	RESISTOR: 20 meg, 10%, ½ W, composition.		.10
R32	18670-101	RESISTOR: 0.4 ohms, 1 W, spool, small.		.60
R33	18525-45	RESISTOR: 20,000 ohms, 2%, ½ W, composition, paired.		.35
R39	18525-176	RESISTOR: 560,000 ohms, 10%, ½ W, composition.		.10
R40	18575-40	RESISTOR: 1800 ohms, 10%, 2 W, composition.		.20
R41	18525-126	RESISTOR: 33,000 ohms, 10%, ½ W, composition.		.10
R42	18525-223	RESISTOR: 330,000 ohms, 10%, ½ W, composition.		.10
R44	18450-7	RESISTOR: 3000, ohms, 10%, ½ W, paired.		.10
R45	18525-155	RESISTOR: 220,000 ohms, 10%, ½ W, composition.		.10
R46	18475-44	RESISTOR: 1,000 ohms, 10%, ½ W.		.10
S1	19912-95	SWITCH: 3 pole, 7 position, 5 section, ceramic	RANGE switch	2.50
S2	19912-94	SWITCH: 7 pole, 6 position, 4 section, ceramic	SELECTOR switch	2.25
S3	19911-9	SWITCH: toggle, SPST	Power OFF-ON	.50
T1	20800-59	TRANSFORMER: pri, 115-230 V; sec, 6.3 V @ 2.5A, sec. 300 vct @ 25 mils.	Power supply transformer.	2.50
V1	20875-22	TUBE: 6X5GT	A-c input rectifier	.70
V2	20875-17	TUBE: 6SJ7	Cathode follower	.80
V3	20875-19	TUBE: 6SN7	Bridge tube	1.15
V4		TUBE: Same as V1	Power supply rectifier	.70
VR1	20875-39	TUBE: OD3/VR150	Voltage Regulator	.75
	3030-23	CABLE: d-c 42" shielded cable, yellow	D-c lead	1.75
	3030-2	CABLE: a-c 42" shielded cable, red	A-c lead	1.75
	3675-1	CORD: a-c line, 8' long	A-c power line	.50
	4160-12	DIAL ASSEMBLY: dial and knob assembly	SELECTOR switch control	1.00
	4160-13	DIAL ASSEMBLY: dial and knob assembly	RANGE switch control	1.00
	10300-8	JACK: red, pin plug		.10
	10300-11	JACK: black, pin plug		.10
	11500-10	KNOB BAR: black bakelite.		.15
	12270-5	LAMP: 6/8 V, 15 A, miniature screw base		.15
	12450-93	LEAD: 42" unshielded lead, red	Ohmmeter measurement	1.00
	12450-99	LEAD: 42" unshielded lead, black	For ground and -MILS connections	1.00
	14175-1	NUT: acorn, 6X32-3/8", NC-2 chrome plated		.10
	14147-6	NUT: acorn, 10X32-3/8", hex steel, nkpl.		.10
	19350-30	SOCKET: octal, molded bakelite		.15
	19350-31	SOCKET: Pilot Lamp, miniature screw base, with red jewel		.40
	20350-17	TERMINAL STRIP: 8 contacts, 6 insulated, 2 grounded		.10
	20350-18	TERMINAL STRIP: 4 contacts, 3 insulated, 1 grounded		.10
	20350-20	TERMINAL STRIP: 6 contacts, 4 insulated, 2 grounded		.10
	20350-22	TERMINAL STRIP: single contact, horizontal		.10
	23190-11	WASHER: 3/8" phenolic, .375" x .750" x .0625"		.05
	23190-2	WASHER: Bakelite extruded, 3/8" ID, 3/4" OD x 1/16" thick, extruded ½" dia x 1/32		.05

SECTION VII DRAWINGS

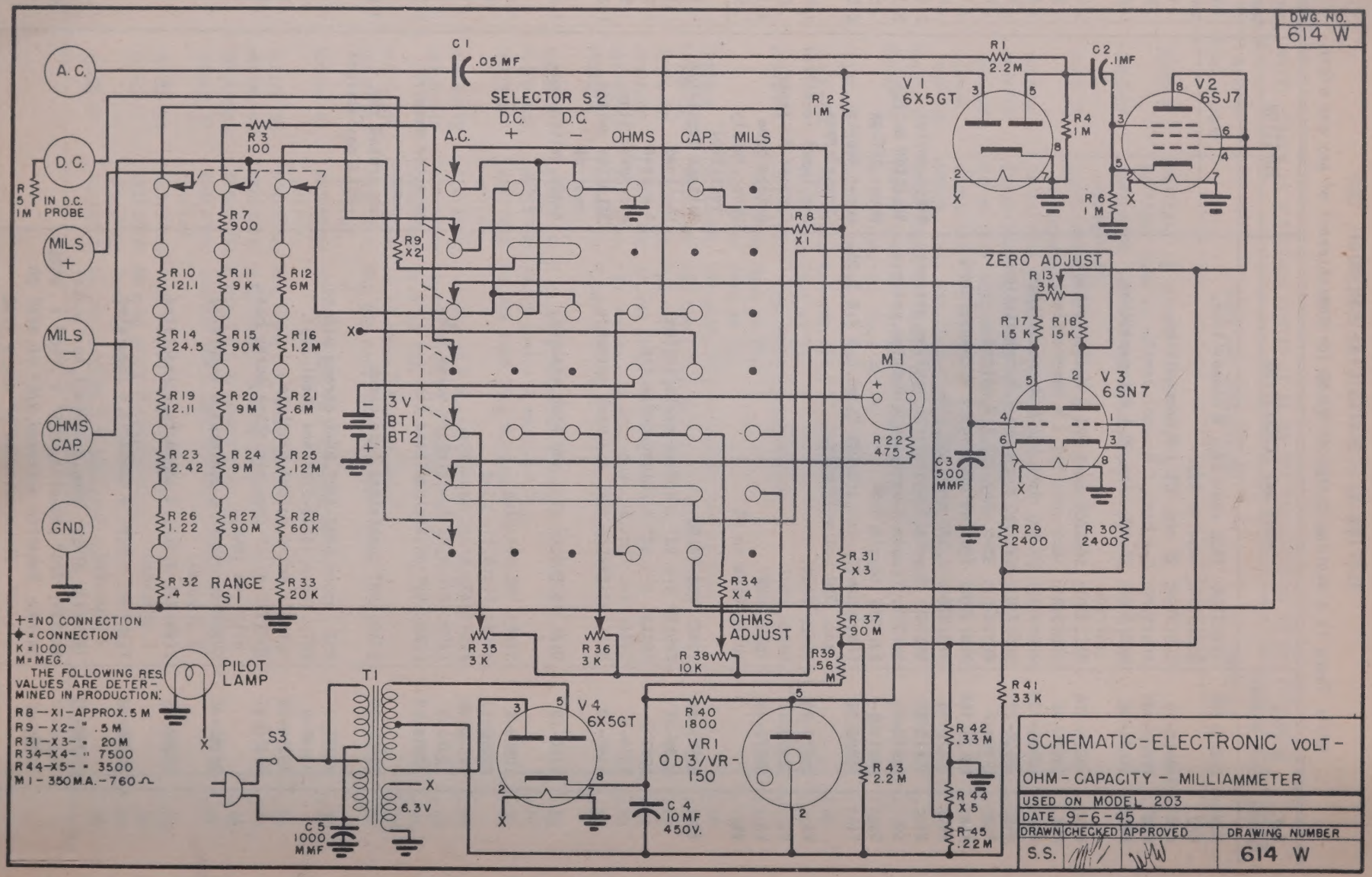


FIGURE 7.1 - Schematic, Model 203

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